

IPC-2547

Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Test, Inspection and Rework



Endorsed by the National Electronics Manufacturing Initiative (NEMI)

IPC-2547

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A standard developed by IPC

3000 Lakeside Drive, Suite 309S, Bannockburn, IL 60015-1219
Tel. 847.615.7100 Fax 847.615.7105
www.ipc.org

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Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

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- Increase time-to-market
- Keep people out
- Increase cycle time
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- Contain anything that cannot be defended with data

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Adopted October 6. 1998

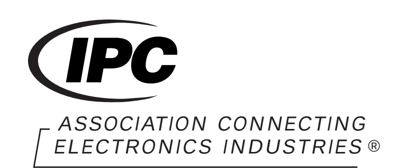
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IPC-2547



– TEST

Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Test, Inspection and Rework

A standard developed by the Inspection and Test XML Schema Formatting Task Group (2-13c) of the Shop Floor Communications Subcommittee (2-13) of IPC.

The IPC-2547 standard defines an the XML encoding schema, applied for the specific printed board assembly inspection and test equipment including manual visual inspection stations (MVI), automatic optical inspection stations (AOI), automatic laser inspection stations (ALI), manual x-ray (MXI), automatic x-ray inspection stations (AXI), flying-probe in-circuit test stations (FPT), bed-of-nails in-circuit stations (ICT) and functional test stations (FNT).

This project was initiated by the NEMI Plug-and-Play Factory Project which established proof of concept. After completion, the project leaders recommended standardization by IPC under the ANSI rules and procedures.



March 20, 2002

Users of this standard are encouraged to participate in the development of future revisions.

Contact:

IPC
3000 Lakeside Drive, Suite 309S
Bannockburn, Illinois
60015-1219
Tel 847 615.7100
Fax 847 615.7105

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the Inspection and Test XML Schema Formatting Task Group (2-13c) of the Shop Floor Communications Subcommittee (2-13) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

Shop Floor Communications Subcommittee	Inspection and Test XML Schema Formatting Task Group	Technical Liaison of the IPC Board of Directors
Chair Allan Fraser GenRad Inc.	Chair Bob Neal Agilent Technologies	Dr. William Beckenbaugh Sanmina

Inspection and Test XML Schema Formatting Task Group

Tom Baggio, Panasonic Factory Automation Company

Cord Burmeister, Siemens Dematic AG

Tom Dinnel, Universal Instruments

Andrew D. Dugenske, Georgia Institute of Technology

Allan Fraser, GenRad Inc.

Frank Gearhart, Assembleon

Yoshiyuki Hattori, Matsushita Electric Industrial Co. Ltd.

Mike Hamblin, GenRad Inc.

Nam Hoang, KIC

Dave Kerem, Camalot Division, Speedline Technologies

Miles Moreau, KIC

Dave J. Morris, Nortel Networks

Hitoshi Nakamura, Matsushita Electric Industrial Co. Ltd.

Bob Neal, Agilent Technologies

Andy Oughton, DEK Printing Machines Ltd.

Jim Perilli, MPM Division, Speedline Technologies

Jari Pirkola, JOT Automation

Mike Rogers, DEK Printing Machines Ltd.

Hannu Ronkainen, JOT Automation

Bob Voitus, Celestica Inc.

Mark Williams, Motorola

A special note of thanks goes to the following individuals for their dedication to bringing this project to fruition. We would also like to highlight those individuals who were involved with the initial NEMI program concept and made major contributions to the development of the standard.

Allan Fraser, GenRad, Incorporated

Robert E. Neal, Agilent Technologies

Bob Voitus, Celestica, Inc.

Andy Dugenske, Georgia Institute of Technology

Dave Morris, Nortel Networks

Mark Williams, Motorola

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Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Test, Inspection and Rework

Introduction

Factory Information Systems (FIS) form the nervous system of an enterprise, analyzing data and delivering information to the machines and people who need to make information-based decisions. These systems provide a bi-directional flow of information between the factory floor and the rest of the enterprise and beyond.

The CAMX standards (IPC 254X) are designed to foster application integration and shop floor equipment communications based on XML. It assumes that application programs (including equipment interfaces) are distinct entities, and application integration takes place using a loosely coupled, message-passing approach. There is no need for a common object model, programming language, network protocol, persistent storage mechanism or operating system for two applications to exchange XML messages formatted using the CAMX standards. The two applications simply need to be able to format, transmit, receive and consume a standardized XML message.

1 Scope

This document describes event message content and an XML encoding scheme, that enables a detailed definition of messages in the domain of electronics inspection, test and repair/rework (i.e. product and process quality). These messages are to be encoded at a level appropriate to facilitate interoperability in the factory shop floor equipment and information system integration process.

1.1 Interpretation

"**Shall**", the emphatic form of the verb, is used throughout this standard whenever a requirement intended to express a provision that is mandatory. Deviation from a **shall** requirement is not permitted, and compliance with the XML syntax and semantics **shall** be followed without ambiguity, or the insertion of superfluous information.

The words "should" and "may" are used whenever it is necessary to express non-mandatory provisions.

"Will" is used to express a declaration of purpose.

To assist the reader, the word **shall** is presented in bold characters.

2 Applicable documents

The following documents contain provisions that, through reference in this text, constitute provisions of this standard. All documents are subject to revision. Parties who make agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below.

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC 2500 Virtual Factory Information Interchange Framework definitions

IPC 2511 Generic Computer Aided Manufacturing (GenCAM) descriptions for Printed Circuit Boards and Printed Board Assembly

IPC 2541 Generic Requirements for Electronics Manufacturing Shop-Floor Equipment Communication Messages (CAMX)

IPC-2546 Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Assembly

W3C Date-time format standard

3 General Requirements

The requirements of IPC-2541 are a mandatory part of this standard. That document describes the generic requirements for the CAMX format.

3.1 Terms and Definitions

The definition of all terms used herein **shall** be as specified in IPC-T-50, and the following:

Assembly
An electronic product consisting of a printed circuit board or boards, attached electronic and mechanical components with associated connectors and cabling.

Base-64
A method of encoding binary data into a restricted, printable ASCII characters subset. This method is used by the inspection systems for encoding their binary image format, such as .tif, jpg, and .bmp.

Board
A single instance of a printed circuit. One circuit image of a fabrication panel. The foundation of an electronic printed circuit assembly.

Component
A single instance of a part package. Identified by an alpha-numeric designator, each of these will have a unique location on a circuit assembly.

Defect
An unacceptable deviation from a norm.

Event
A process action or trigger of significance. Also a term used in this standard as synonymous with message records generated upon the event occurrence.

Fault
The detected manifestation of a defect.

Frame
An instance of a captured optical, x-ray, or infra-red picture, image or other artifact facsimile of a circuit board or assembly. A Frame may be of a relatively small geometry or it may represent an entire assembly.

Image
A single board or assembly circuit instance typically used to identify one member of a homogeneous or heterogeneous panel, but not limited to that.

Item
An identifiable and traceable product or product component instance.

Indictment
A defect condemnation identified during human or automated inspection or test.

Octet
A measured or expected value expressed as an 8-bit byte. Measured and expected values that are not necessarily numeric in nature (e.g. character strings) are expressed and compared as octets.

Panel
An electronic assembly consisting of multiple circuit images. Homogeneous panels are defined as having multiple of the same circuit image revision and assembly (Bill of Materials) revision. Heterogeneous panels are defined a having more than one circuit image and/or more than one assembly revision.

Inspection
A process relating to one or more regions-of-interest of a board or an assembly.

Region Of Interest (ROI)
An area of focus in or on an electronic assembly pertinent to inspection.

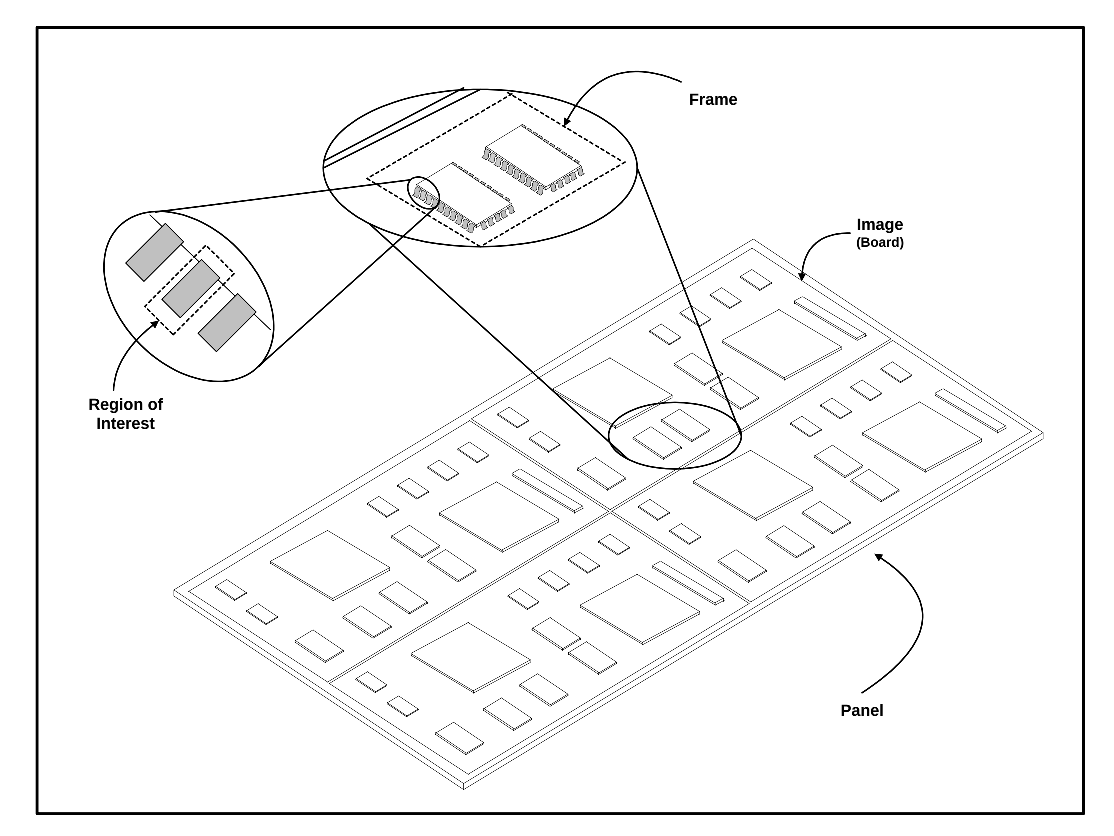


Figure 1 Inspection Frame and Inspection Region of Interest

Signal
An electrically-common logical net or physical conductor or connection.

Station
A uniquely identifiable, task-specific work area of a manufacturing environment.

Stage
A uniquely identifiable task within the sequence of manufacturing steps for electronic assemblies.

Symptom
Description of an element of evidence of a fault or defect.

Termination
A lead, pin, ball, leg or other conductive connection between a component package and the circuit board.

3.2 Date and Time Notation

All 2540 standards **shall** use the World Wide Web consortium (W3C) date time standard. This standard **shall** use the Complete Date plus Hours, Minutes, Seconds, and a decimal fraction of a second and Time Zone Designator. Two decimal places will be used in order to represent time down to a hundredth of a second. For additional information on date and time, see web page:

http://www.w3.org/TR/1998/NOTE-datetime-19980827

3.3 CAMX Compliance

The IPC-2501 document defines a message packet structure. The IPC-2541 document defines a set of Equipment, Recipe, Item, and Operator events and related message formats. All test, inspection and repair stations that comply with the IPC-2547 standards **shall** also comply with the event messages contained in the IPC-2541 standard as well as those events that are described in this document. All event messages **shall** be formatted in compliance with the IPC-2501 message packet structure. For consistency in XML style, all CAMX XML Element and attribute names **shall** be in mixed-case with Element names beginning with an upper case letter and attribute names beginning with a lower case letter. XML Elements are order specific and **shall** appear in the order prescribed in the XML schema definitions.

4 Test and Inspection Specific Event Messages

The figure below illustrates the relationships and cardinality of the key event elements.

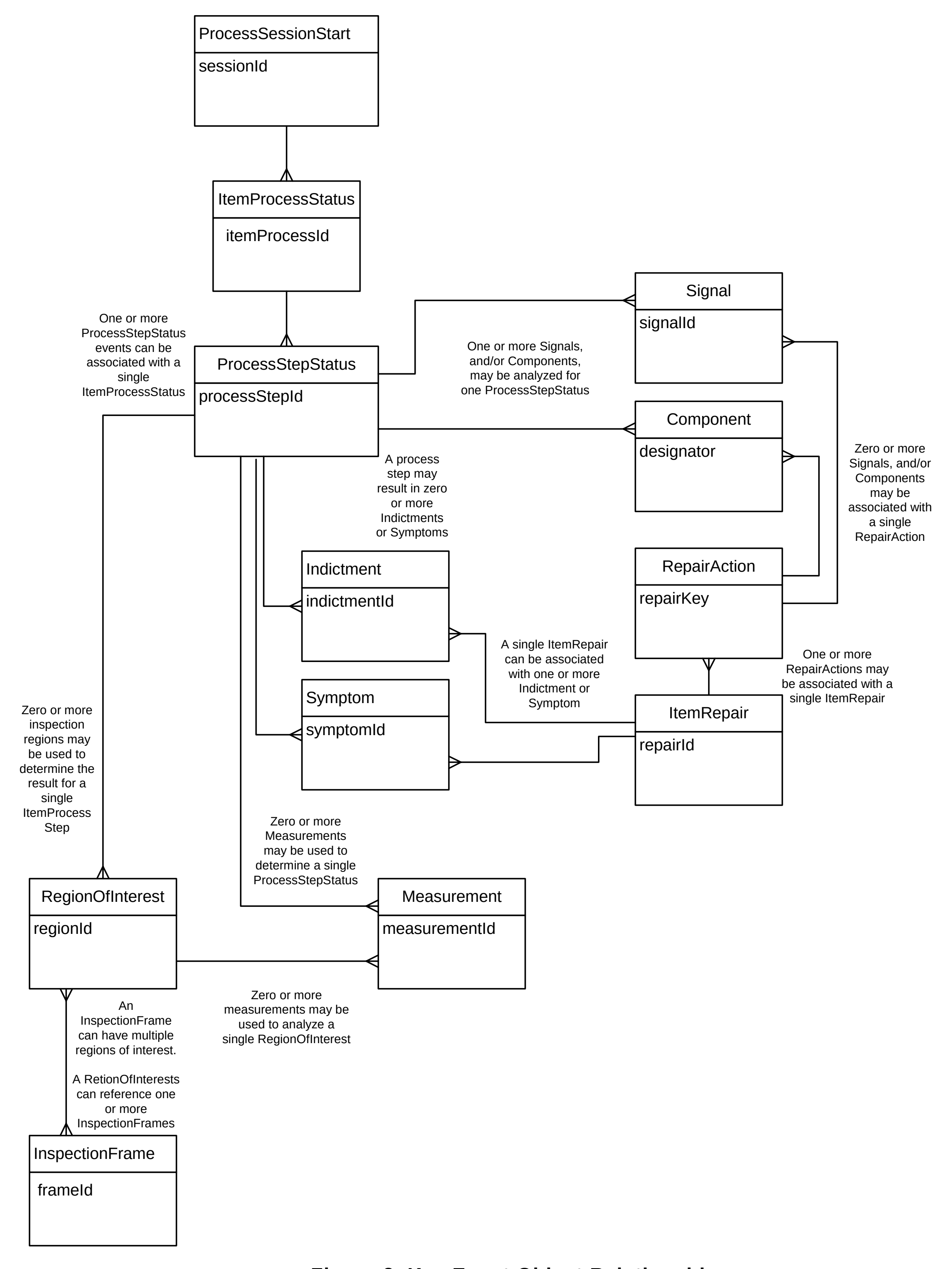


Figure 2 Key Event Object Relationships

Though the events are asynchronous, the relationships are linked using identifiers and identifier references for grouping the event records. Each session has an identifier that shall be unique across at least the reporting domain. The recommendation is to use a date-time in conjunction with a MAC or IP address, *GUID* or Java-style organization package path. For example:

- Network address and date-time (`"15.11.9.54-2000-08-05T10:04:31.20+0800"`)
- Enterprise Id and date-time (`"com.ourco.mch2-2000-08-05T10:04:31.20+0800"`)

This identifier is then referenced in each ItemProcessStatus There is one ItemProcessStatus for one execution of the test or inspection program. In turn, each ItemProcessStatus has an indentifier unique within the reporting domain that is referenced in the ProcessStepStatus event for each step of the test or inspection program. Similarly each supporting inspection or test step has an identifier that is unambiguous within the test or inspection program's sequencing. Indictments or symptoms of failing test steps are also unabiguously identified, enabling association with repair events and repair actions.

The tables in this section define the event message attributes that are appropriate for test, inspection, and repair/rework functions. These events are necessary for tracking product and process quality as well as enabling identification and intelligent correlation of fault signatures to effective repair actions. The right-most column (labeled Occ) indicates the expected number of occurrences (cardinality) of each attribute or element. 0-1 indicates an optional field. 1-1 indicates a single mandatory field. 0-n indicates any number, including zero. 1-n indicates at least one.

4.1 Management Event - ProcessSessionStart

In recognition that there is a need for information to be shared between factory equipment and processes this event message has been defined to meet this need. There are typically many items processed during one session. Consider this message as an event separator that can be triggered by the equipment itself or by a change in its environment, including a new operator, a shift change, a change in the product or in the program/recipe.

4.1.1 Event: ProcessSessionStart

Description: The ProcessSessionStart record provides information regarding the product, process, location and environment.

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
sessionId	string	Domain unique identifier of this process session	1-1
Product	Element	Identifies the type, lot, batch etc. of the product	1-1
Entity	Element	Identifies the location and enterprise	1-1
shift	string	Identify the work interval.	0-1
Recipe	Element	Identifies the process program, model, best practices or algorithms	0-n
Operator	Element	Equipment operator identifier	0-n
FixtureTooling	Element	Identifies the test fixture(s) if applicable	0-n

4.1.2 Element: Product

Description: The Product element uniquely describes the item and its groupings.

Attribute Name	Attribute Type	Description	Occ
itemType	string	Product type id	1-1
itemClass	string	Identify the product classification such as system, assembly, board,	0-1
boardRevision	string	Identify the board layout revision	0-1
assemblyRevision	string	Identify the assembly version (i.e. bill of materials)	0-1
workOrder	string	Identify the product work order	0-1
batch	string	Identify the product batch	0-1
lot	string	Identify the product lot	0-1
count	positiveInteger	The number of product in the lot or batch	0-1

4.1.3 Element: Operator

Description: The Operator element **shall** contain a unique identifier for the operator such as their employee number or social security number, and may also contain a personal identifier such as the person's name, nickname or logon name.

Attribute Name	Attribute Type	Description	Occ
employeeId	string	Employee number, login name or internal identifier	1-1
givenName	string	Employee's first name	0-1
familyName	string	Employee's last name	0-1

4.1.4 Element: Entity

Description: The Entity element uniquely describes the equipment or process station.

Attribute Name	Attribute Type	Description	Occ
stationId	string	Process station identifier unique to the domain	1-1
stage	string (enumerated)	Process step. One of: MVI | ALI | AOI | MXI | AXI | MDA | FPT | ICT | FNT | INT | SYS | OLT	1-1
stationRevision	string	Identify the station’s hardware revision if applicable	0-1
subStage	string	Additional information regarding the stage, station or processing.	0-1
line	string	Identifier for this manufacturing line or cluster	0-1
building	string	Identify the building	0-1
site	string	Identify the site or location	0-1
enterprise	string	Identify the company	0-1

4.1.5 Element: Recipe

Description: The Recipe element uniquely identifies the recipe, program, algorithms or best practices being executed at the station or specified station zones and/or lanes. The attributes zoneList and laneList are defined using the XML string list syntax specified as a single quoted string containing white-space (e.g. SPACE, TAB) separated, alpha-numeric character groups.

Attribute Name	Attribute Type	Description	Occ
recipeId	string	Identifies the name of the program	1-1
revision	string	Identifies the revision of the program	1-1
zoneList	string (list)	Identifies the zone(s) executing this recipe	0-1
laneList	string (list)	Identifies the lane(s) executing this recipe	0-1
RecipeModule	Element	Identifies the files or individual parts of a multiple part recipe	0-n

4.1.6 Element: RecipeModule

Description: The RecipeModule element uniquely identifies a single component of the recipe, program, algorithms or best practices being executed at the station and identifies its type.

Attribute Name	Attribute Type	Description	Occ
moduleId	string	Identifies the name of the recipe part	1-1
revision	string	Identifies the revision of the recipe part if applicable	0-1
type	string (enumerated)	Identifies the entry type as one of ALGORITHM | CONFIGURATION | DOCUMENTATION | EXECUTIVE | FIRMWARE | LIMITS | SEQUENCE | SETUP	0-1

4.1.7 Element: FixtureTooling

Description: The FixtureTooling element uniquely describes the test fixture and can be used to track its actuation count for probing accuracy and maintenance purposes.

Attribute Name	Attribute Type	Description	Occ
fixtureId	string	Identify the test fixture	1-1
revision	string	Identify the revision of the fixture	1-1
serialNumber	string	Identify the particular fixture instance	0-1
type	string	Identify the fixture type or function	0-1

```
<ProcessSessionStart
    dateTime="2000-08-05T10:04:31.20+0800"
    sessionId="NewCo3070-2-2000-08-05T10:04:31.20+0800"
    shift="FIRST">
    <Operator
        employeeId="0024335"
        givenName="Jane"
        familyName="Wilson"/>
    <Entity
        stationId="NewCo3070-2"
        stage="ICT"
        line="3"
        building="B6"
        site="Hillsboro"
        enterprise="CPUCo"/>
    <Recipe
        recipeId="11356-66540"
        revision="3"
        zoneList="3 4 5"
        laneList="1 2"/>
    <FixtureTooling
        fixtureId="11356-66540\2"
        revision="A"/>
    <Product
        itemType="11356-66540"
        boardRevision="B-20000512"
        assemblyRevision="4"
        workOrder="Cpq4592-002"
        batch="12"
        count="144"/>
</ProcessSessionStart>
```

4.2 Event: ProcessSessionEnd

Description: The ProcessSessionEnd record is optional, and can be used as the companion to the ProcessSessionStart record and serve to close the process session.

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
sessionId	string	Globally unique identifier of this process session	1-1

```
<ProcessSessionEnd
    dateTime="2000-08-05T10:04:31.20+0800"
    sessionId="NewCo3070-2-2000-08-05T10:04:31.20+0800"
                              />
```

4.3 Event: InspectionFrame

Description: An image frame captured for analysis.

The InspectionFrame message describes an inspection frame, uniquely identifying it and providing its size and location in relationship to the board origin. The data payload may include the base-64 encoded image file (e.g., gif, tif, jpg, png) binary. There are typically many InspectionFrame events per item (board, panel or assembly).

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
itemInstanceId	string	Item instance identifier	1-1
sessionRef	string	References the session in which this event occurred	1-1
itemProcessRef	string	References the process that captured the frame	1-1
frameId	string	Unique identifier for this frame for later reference	1-1
Region	Region Element	Identify the frame region and orientation with respect to the board origin.	1-1
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1
frameStatus	string (enumerated)	PASSED | FAILED Frame either contains zero failing regions-of-interest (PASSED) or contains one or more failing regions (FAILED).	0-1
layer	string	Identify board surface or layer of the frame if applicable. This can be the slice of an x-ray inspection or absent for multiple-frame x-ray image synthesis.	0-1
Base64Encoding	Base64 Element	Encoded frame element	0-1

4.3.1 Element: Region

Description: A rectangular or circular area definition. Point1X and point1Y attributes are always required. If the point2X and point2Y attributes are present then the region is analyzed as rectangular. If point2X and point2Y are not present then the diameter attribute **shall** be present and the region is analyzed as circular.

Attribute Name	Attribute Type	Description	Occ
units	string (enumerated)	Coordinate units (INCH | MM | PIXEL)	1-1
point1X	double	The region origin X value	1-1
point1Y	double	The region origin Y value	1-1
point2X	double	The opposite corner X value if rectangular	0-1
point2Y	double	The opposite corner Y value if rectangular	0-1
diameter	double	The diameter if a circular region	0-1
decade	double	Unit multiplier in powers of 10 (default is 0).	0-1
Orientation	Element	Rotation of the region vs. the board.	0-1

4.3.2 Element: Orientation

Description: The Orientation element describes the rotation (theta) of an InspectionFrame region with respect to its parent board or the rotation of a RegionOfInterest with respect to its InspectionFrame.

Attribute Name	Attribute Type	Description	Occ
value	double	Rotation value	1-1
units	string (enumerated)	Rotation units (DEGREES|RADIANS)	1-1

4.3.3 Element: Base64Encoding

Description: The Base64Encoding element identifies the MIME type of the binary and its encoding. If the binary is decoded at its destination and written to the file system it is given the name and the suffix associated with the type.

Attribute Name	Attribute Type	Description	Occ
name	string	File name	1-1
mimeType	string	Frame MIME type (suffix)	1-1
encoding	string	Base-64 encoded frame	1-1

```
<InspectionFrame
    dateTime="2000-08-05T10:04:31.20+0800"
    itemInstanceId="66540A00343"
     sessionRef=="NewCo3070-2-2000-08-05T10:04:31.20+0800"
```

```
itemProcessRef="20111954-2000080510043120+08"
imageId="3"
frameId="382"
frameStatus="FAILED"
layer="2">
<Region
   point1X="2000"
   point1Y="3000"
   point2X="2750"
   point2Y="3750"
   units="INCH"
   decade="-3">
   <Orientation value="90" units="DEGREES"/>
</Region>
<Base64Encoding
   name="382"
   mimeType="JPG"
   encoding="XXXXXXXXXX- Base 64 Encoded Binary Image -XXXX"
/>
</InspectionFrame>
```


4.4 Event: ItemProcessStatus

Description: Processing of an item has completed, and the process task issues an overall status for the processed item.

This message reports the overall status of a complete test or inspection of a product item. This message is intended to satisfy those applications that analyze product quality using such measures as first pass yield. If the item arrived at the equipment but was passed through and not processed then a status of NOTEST is reported. If the equipment's test or inspection process was interrupted then a status of ABORTED is reported. If an equipment hardware or software error occurs that precludes a successful completion of the process then a status of ERROR is reported. If any of the individual test or inspection steps produced a failing status then the overall status **shall** be FAILED. Otherwise the overall status **shall** be PASSED. The exception to this is when a known-good item is being processed for the purpose of equipment calibration or program verification. To identify these process step executions and prevent the skewing of the statistical analysis of the process, the status should be set to KNOWNGOOD.

ItemEventCount element should be included within the ItemProcessStatus event and is generated for purposes of data integrity. Due to the nature of network transport of IPC-2547 event messages, this record is provided to assure that the client has received all of the messages that were sent regarding the processing of an item at a test or inspection stage. This message is for information purposes only. There is no recommendation of appropriate action to be taken when the number of event messages received does not match the count in the ItemEventCount.

Attribute Name	Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
itemInstanceId	string	Item instance identifier	1-1
sessionRef	string	A reference to the unique process session identifier	1-1

itemProcessId	string	An identifier for a single process execution that is unique within the physical and temporal domains of the session.	1-1
status	string (enumerated)	NOTEST | PASSED | FAILED | ABORTED | ERROR | KNOWNGOOD	1-1
mode	string (enumerated)	ENGINEERING | CALIBRATION | PRODUCTION	0-1
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1
itemParentId	string	Identify parent of instance if panelized	0-1
ItemEventCount	Element	Provides a count of published events associated with the processing of this item.	0-n
comment	string	Any additional information at the whole process level.	0-1

4.4.1 Element: ItemEventCount

Description: The count of IPC-2547 events associated with this item and process.

Attribute Name	Attribute Type	Description	Occ
eventType	string (enumerated)	INSPECTIONFRAME | PROCESSSTEPSTATUS	1-1
count	nonNegativeInteger	The number of event records sent	1-1

```
<ItemProcessStatus
      dateTime="2000-08-05T10:04:31.20+0800"
      itemInstanceId="66540A00343"
      sessionRef="NewCo3070-2-2000-08-05T10:04:31.20+0800"
      itemProcessId="20111954-2000080510043120+08"
      status="PASSED"
      mode="PRODUCTION"
      imageId="4">
   <ItemEventCount eventType="INSPECTIONFRAME" count="347"/>
   <ItemEventCount eventType="PROCESSSTEPSTATUS" count="6492"/>
</ItemProcessStatus>
```

4.5 Event: ProcessStepStatus

Description: An inspection or measurement step has been executed and a resulting status for the individual step has been determined.

Execution of a Measurement or Inspection process step triggers the issuing of a ProcessStepStatus event. This step status event **shall** be unambiguously identified within the test or inspection program execution (e.g. processStepId or processStepId + sequence) and **shall** provide a reference to the overall process event and to the session event.

If the process step is incomplete due to temporal or equipment limit conditions then the ProcessStepStatus **shall** be NOTEST. If an equipment error (e.g. fiducial, barcode) occurs that precludes a successful completion of the step then a status of ERROR **shall** be reported. Otherwise the ProcessStepStatus **shall** be PASSED or FAILED. If the status is FAILED then

one or more Indictment or Symptom elements may be included in the event. Each ProcessStepStatus event may reference one or more RegionOfInterest or Measurement events that contributed to the status, and may also contain one or more Symptom and/or Indictment elements as well as associated Component or Signal elements.

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
itemInstanceId	string	Item instance identifier	1-1
sessionRef	string	References the session for this event	1-1
itemProcessRef	string	References the overall process issuing the status	1-1
processStepId	string	Identify the process step leading to the status.	1-1
status	string (enumerated)	PASSED | FAILED | NOTEST | ERROR	1-1
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1
sequence	positiveInteger	Execution/presentation order or disambiguation	0-1
comment	string	Additional free-format information	0-1
Error	Element	Additional information supporting a status of ERROR	0-n
Symptom	Element	Identify an observed anomaly if applicable	0-n
Indictment	Element	Identify the defect type if applicable	0-n
RegionOfInterest	Element	Inspection region(s) associated with this step	0-n
Measurement	Element	Measurement(s) associated with this step	0-n
Component	Element	Associated component(s)	0-n
Signal	Element	Associated signal network(s)	0-n

4.5.1 Element: Error

Description: This element is sent by a piece of equipment when it cannot process an item to produce a meaningful PASS/FAIL status. This event differs from the IPC-2541 EquipmentError in that it does not halt the equipment and does not require operator or host intervention.

Attribute Name	Attribute Type	Description	Occ
errorId	string	Error identifier	1-1
description	string	The error symptom or other diagnostic information.	0-1
recipeRef	string	Reference the recipe being executed	0-1
moduleRef	string	Reference the recipe module if applicable	0-1
recipeStep	string	Identify the recipe step or command	0-1
lane	string	Identify the lane	0-1
zone	string	Identify the zone	0-1

4.5.2 Element: Symptom

Description: This element provides detailed information on a measured or observed fault. The symptomKey attribute should be specific. (See Appendix-B for a suggested list of symptom keys.) The confidence attribute value expresses a low (0) confidence to high (100) confidence in the observation or measurement to identify a defect. The category attribute can provide a keyword to be used for such functions as diagnostics, routing, closed loop quality.

Attribute Name	Attribute Type	Description	Occ
symptomId	string	Identifier for this symptom record with which to associate one or more repair actions.	1-1
symptomKey	string	Identifies product or process faults (See Appendix B)	1-1
category	string	Additional key, if known (See Appendix E)	0-1
description	string	Additional free format information (comment)	0-1
confidence	nonNegativeInteger (100-0)	Relative confidence in the symptomKey accuracy	0-1
MeasurementRef	Element	Reference to the Measurement Id(s) associated with this event	0-n
RegionRef	Element	Reference to the RegionOfInterest Id(s) associated with this event	0-n

4.5.3 Element: Indictment

Description: This element provides specific information supporting a failing ProcessStepStatus. The indictmentKey attribute should be specific. (See Appendix-C for a suggested list of indictment keys.) The priority attribute is expressed in a value from high (1) priority to an open-ended low priority (n) of the indictment. The confidence attribute value expresses a low (0) confidence to high (100) confidence in the indictment. The category attribute can provide a keyword to be used for such functions as diagnostics, routing, closed loop quality.

Attribute Name	Attribute Type	Description	Occ
indictmentId	string	Identifier for this indictment record with which to associate one or more repair actions.	1-1
indictmentKey	string	Identifies product or process faults (See Appendix C)	1-1
category	string	Additional key, if known. (See Appendix E)	0-1
description	string	Additional free format information (comment)	0-1
priority	positiveInteger	Presentation of an unbounded priority of the indictment where 1 = highest priority.	0-1
confidence	nonNegativeInteger (100-0)	Relative confidence in the indictmentKey accuracy	0-1
MeasurementRef	Element	Reference to the Measurement Id(s) that lead to this indictment	0-n
RegionRef	Element	Reference to the RegionOfInterest Id(s) that lead to this indictment.	0-n

4.5.4 Element: RegionOfInterest

Description: A sub-region of an item or an inspection frame.

Manual inspection can be of an item component, region or point. With automated inspection technologies the imaging device (e.g. camera) captures a frame. One or more regions of interest (ROI) of the frame(s), scan(s) or field(s)-of-view is analyzed. The RegionOfInterest element is uniquely identified and describes one inspection region and the analysis that combines to justify the ProcessStepStatus. The X and Y points describing the inspected region or location are themselves elements containing a value in one of three units: millimeter (MM), inch (INCH) or pixel (PIXEL). If an InspectionFrame is referenced then the location of the RegionOfInterest **shall** be with relation to the InspectionFrame origin.

Attribute Name	Attribute Type	Description	Occ
regionId	string	Unique identifier for the inspection region	1-1
frameRef	string (list)	Reference to one or more frame elements	0-n
layer	string	Identify board surface or layer of the region.	0-1
status	string (enumerated)	Option to report (PASSED | FAILED) status of the inspection of the point, region or component.	0-1
Region	Region Element	Identify the region of interest (ROI) dimensions and orientation.	0-1
Point	Point Element	Identify an exact (X,Y) point of interest	0-1
Component	Component Element	Identify associated component or feature inspected	0-1

4.5.5 Element: Point

Description: Provides an XY ordered pair with units and decade (order of magnitude).

Attribute Name	Attribute Type	Description	Occ
pointX	double	X Parameter value	1-1
pointY	double	Y Parameter value	1-1
units	string (enumerated)	Parameter units (MM | INCH)	1-1
decade	double	Unit multiplier in powers of 10 (default is 0).	0-1

4.5.6 Element: Measurement

Description: When the test or inspection of an item results in measured values, those measurements are described using the Measurement event. This is true whether the measurement is a numeric value, a string value, or a bit sequence or an array of any of these. Measured values **shall** be one of MeasuredNumeric or MeasuredOctet so that the values can be reported and correctly parsed. Similarly, expected values **shall** be one of ExpectedNumeric or ExpectedOctet.

Attribute Name	Attribute Type	Description	Occ
measurementId	string	Identify the measurement by a name unique within this item process. (test program)	1-1
mode	string	Additional information about the measurement result	0-1
type	string	Identify the type of measurement	0-1
sequence	positiveInteger	Identify the sequence number if applicable	0-1
status	string (enumerated)	Option to report (PASSED | FAILED) status.	0-1
MeasuredNumeric	Element	A numeric value measured	0-n
MeasuredOctet	Element	A string, byte or bit sequence value measured	0-n
ExpectedNumeric	Element	A numeric value and range expected.	0-n
ExpectedOctet	Element	A string, byte or bit sequence value expected	0-n
Component	Element	Identify associated component(s)	0-n
Signal	Element	Identify associated signal network(s)	0-n

4.5.7 Element: MeasuredNumeric

Description: Provides a numeric value.

Attribute Name	Attribute Type	Description	Occ
value	double	Parameter value	1-1
units	string	Units of measure	0-1
decade	double	Unit multiplier in powers of 10 (default is 0).	0-1
position	string (list)	Describe the positional location if the expression is for a multidimensional array of values	0-1

4.5.8 Element: MeasuredOctet

Description: A measured string, byte or bit sequence value.

Attribute Name	Attribute Type	Description	Occ
value	string	Measured sequence	1-1
position	string (list)	Describe the positional location if the expression is for a multidimensional array of values	0-1

4.5.9 Element: ExpectedNumeric

Description: An expected numeric value, units and decade with minimum and maximum values that define the measurement tolerance *window*. Minimum and maximum limits **shall** be in the same units and decade as the nominal. When nominal, minimum and/or maximum attributes are present the minimum **shall** be the least, maximum **shall** be the greatest and the nominal **shall** fall between these values.

Comparator Semantics

- EQ **shall** mean equal to the nominal value. The nominal is a required attribute.
- NE **shall** mean not equal to the nominal value. The nominal is a required attribute.
- GT **shall** mean greater than the minimum. The minimum is a required attribute.
- LT **shall** mean less than the maximum. The maximum is a required attribute.
- GE **shall** mean greater than or equal to the minimum. The minimum is a required attribute.
- LE **shall** mean less than or equal to the maximum. The maximum is a required attribute.
- GTLT **shall** mean greater than the minimum and less than the maximum. Both limits are required attributes.
- GELE **shall** mean greater than or equal to the minimum and less than or equal to the maximum. Both limits are required attributes.
- GTLE **shall** mean greater than the minimum and less than or equal to the maximum. Both limits are required attributes.
- GELT **shall** mean greater than or equal to the minimum and less than the maximum. Both limits are required attributes.
- LTGT **shall** mean less than the minimum or greater than the maximum. Both limits are required attributes.
- LEGE **shall** mean less than or equal to the minimum or greater than or equal to the maximum. Both limits are required attributes.
- LTGE **shall** mean less than the minimum or greater than or equal to the upper limit. Both limits are required attributes.
- LEGT **shall** mean less than or equal to the lower limit or greater than the upper limit. Both limits are required attributes.
- If no comparator is expressed the following **shall** apply:
- If both limits are present then the default **shall** be GELE. (the nominal is optional).
- If only the upper limit is present then the default **shall** be LE.
- If only the lower limit is present then the default **shall** be GE.
- If only the nominal is present then the default **shall** be EQ.

<table>
<tr><th>Attribute Name</th><th>Attribute Type</th><th>Description</th><th>Occ</th></tr>
<tr><td>nominal</td><td>double</td><td>Expected value in the described units and decade</td><td>0-1</td></tr>
<tr><td>units</td><td>string</td><td>Units of measure</td><td>0-1</td></tr>
<tr><td>decade</td><td>double</td><td>Unit multiplier in powers of 10.(default is 0)
(Not applicable to non-numeric measures)</td><td>0-1</td></tr>
<tr><td>minimum</td><td>double</td><td>Actual lower limit bound in the described units and decade</td><td>0-1</td></tr>
<tr><td>maximum</td><td>double</td><td>Actual upper limit bound in the described units and decade</td><td>0-1</td></tr>
<tr><td>comparator</td><td>string (enumerated)</td><td>EQ | NE | GT | LT | GE | LE | GTLT | GELE | GTLE | GELT | LTGT | LEGE | LTGE | LEGT</td><td>0-1</td></tr>
<tr><td>position</td><td>string (list)</td><td>Describe the positional location if the expression is for a multidimensional array of values</td><td>0-1</td></tr>
</table>

4.5.10 Element: ExpectedOctet

Description: An expected string, byte or bit sequence value. The position attribute is defined using the XML string list syntax specified as a single quoted string containing white-space (e.g. SPACE, TAB) separated, alpha-numeric character groups.

<table>
<tr><th>Attribute Name</th><th>Attribute Type</th><th>Description</th><th>Occ</th></tr>
<tr><td>value</td><td>string</td><td>Expected sequence</td><td>1-1</td></tr>
<tr><td>position</td><td>string (list)</td><td>Describe the positional location if the expression is for a multidimensional array of values</td><td>0-1</td></tr>
<tr><td>caseSensitive</td><td>boolean</td><td>TRUE | FALSE (only applies to character string values)</td><td>0-1</td></tr>
</table>

4.5.11 Element: Signal

Description: A measurement or process step has been associated with one or more signal networks. Each signal element is reported within the scope of the event. These elements **shall** uniquely identify the signal net in question by providing the signal name, and when the product is panelized also providing the identifier for the circuit image instance. Signals are most often reported in pairs; for example, electrical shorts.

Attribute Name	Attribute Type	Description	Occ
signalId	string	Identify the signal instance	1-1
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1

4.5.12 Element: Component

Description: A measurement, inspection region or status has an associated component.

Each component is reported within the scope of the event. These elements **shall** describe the component and uniquely identify the component in question by providing the component designator. When the product is panelized the element also provides the identifier for the board image instance. Note that the termination identification is a string that must be parsed to determine the number and range of terminations. A dash (-) character denotes an inclusive sequence while a comma (,) is used to separate sequences or individual terminations.

Attribute Name	Attribute Type	Description	Occ
designator	string	Identify the component instance	1-1
imageId	string	Identify the board image if panelized	0-1
subassembly	string	Identify the subassembly or module	0-1
type	string	See Appendix F for suggested component types	0-1
layer	string (enumerated)	TOP | BOTTOM | INTERNAL	0-1
subcomponent	string	Identify package element	0-1
termination	string format (1..n, 1-m)*	Identify the lead, pin, ball number(s) e.g. "1, 4-6" identifies 1, 4, 5, 6	0-1
partId	string	Identify the device part number from the BOM	0-1
package	string	See Appendix-G for suggested package types	0-1
jointType	string	See Appendix-H for suggested lead joint types	0-1
jointSubtype	string	User defined algorithm identifier	0-1

```
<ProcessStepStatus
    dateTime="2000-08-05T10:04:31.20+0800"
    itemInstanceId="66540A00343"
    sessionRef=="NewCo3070-2-2000-08-05T10:04:31.20+0800"
    itemProcessRef="20111954-2000080510043120+08"
    processStepId="analog_q1"
    status="FAILED">
    <Indictment
      indictmentId="analog_q1-1"
      indictmentKey="COMPONENT VALUE OUT OF TOLERANCE"
      priority="2"
      categoy="MATERIALS"
      confidence = "87"/>
      <MeasurementRef>
        11356-66540-analog/q1/base-collector
      </MeasurementRef>
    </Indictment>
    <RegionOfInterest
       regionId="A2-382-01-Left"
       layer="PRIMARY" frameRef="382 383 384">
       <Region
         point1X="0"
         point1Y="2"
         point2X="1"
         point2Y="4"
```

```
         units="MM">
          <Orientation value="90" units="DEGREES"/>
        </Region>
        <Component
            designator="q1"
            type="PNP"
            layer="PRIMARY"
            partId="54-35-6664"
            package="SOT"/>
        <MeasurementRef>
          11356-66540/q1-SolderVolume
        </MeasurementRef>
     </RegionOfInterest>
     <Measurement
        measurementId="11356-66540-analog/q1/base-collector"
        mode="UNPOWERED"
        type="ANALOG"
            <MeasuredNumeric
               value="0.7"
               units="VOLT"
               decade="0"/>
            <ExpectedNumeric
               nominal="0.7"
               units="VOLT"
               decade="0"
               minimum="0.4"
               maximum="1.5"/>
            <Component designator="q1" type="PNP" layer="PRIMARY"
              partId="54-35-6664" package="SOT"/>
     </Measurement>
     <Measurement
         measurementId="11356-66540-analog/q1/emitter-base"
         mode="UNPOWERED"
         type="ANALOG">
         <MeasuredNumeric
            value="3.0"
            units="VOLT"
            decade="0"/>
         <ExpectedNumeric
            nominal="0.7"
            units="VOLT"
            decade="0"
            minimum="0.4"
            maximum="1.5"/>
         <Component designator="q1" type="PNP" layer="PRIMARY"
            partId="54-35-6664" package="SOT"/>
     </Measurement>
     <Measurement
         measurementId="11356-66540/q1-SolderVolume"
         <MeasuredNumeric
            value="30"/>
     </Measurement>
     <Component designator="q1"/>
 </ProcessStepStatus>
```

4.6 Event: ItemRepair

Description: An item has been repaired, reworked or scrapped.

The ItemRepair event is generated at the repair/rework/debug station based on the action taken by the operator or technician. Each ItemRepair references one or more indictment or symptom events. Multiple RepairAction elements may be included in a single ItemRepair event. Within each repair action is a repairKey that may be user defined. (See Appendix D for a suggested list of repair keys.) Since the operator or technician can often provide more specific information regarding the actual defect, an optional DefectDetail element is available to capture this information for more accurate reporting.

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
itemInstanceId	string	Item instance identifier	1-1
itemProcessRef	string	References the process that issued the defect call	1-1
repairId	string	Identifier for this repair event	1-1
RepairAction	Element	Identifies repair action taken	1-n
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1
stationId	string	Identify the repair station	0-1
SymptomRef	Element	Reference the test/inspection symptom(s) addressed	0-n
IndictmentRef	Element	Reference the test/inspection indictment(s) addressed	0-n
DefectDetail	Element	Detailed or additional defect data	0-n
Operator	Operator Element	Identifies the repair technician	0-1

4.6.1 Element: DefectDetail

Description: More specific information regarding the indictment(s) or symptom(s) has been observed, measured or otherwise obtained.

Attribute Name	Attribute Type	Description	Occ
detailKey	string	Specific, additional or corrective defect detail (See recommended indictments in Appendix C)	1-1
category	string	Additional or overriding causal Information	0-1
comment	string	Additional free format information	0-1

4.6.2 Element: RepairAction

Description: A specific repair action has been taken. This action may involve one or more components, subcomponents or signals.

Attribute Name	Attribute Type	Description	Occ
repairKey	string	Identifies repair action taken (See Appendix D)	1-1
comment	string	Additional Information	0-1
Component	Component Element	Associated Component(s)	0-n
Signal	Signal Element	Associated Signal(s)	0-n
Location	Point Element	The repair (x,y) location	0-1

```
<ItemRepair
      dateTime="2000-08-05T10:04:31.20+0800"
      itemInstanceId="66540A00343"
      imageId="3"
       itemProcessRef="20111954-20000805100431 20+08"
 repairId="20111966-20000805110944"
<RepairAction
         repairKey="COMPONENT REPLACED"
         <Component
                  designator="q1"
                  type="PNP"
                  layer="PRIMARY"
                   partId="54-35-6664"
                  package="SOT"
           />
       </RepairAction>
      <IndictmentRef>analog_q1</IndictmentRef>
      stationId="NewCo-Bldg2-SolderPot-2">
      <DefectDetail
         detailKey="COMPONENT ROTATED"
         category="PLACEMENT"/>
      <Operator
        employeeId="0024335"
        givenName="Jane"
       familyName="Wilson"/>
                     </ItemRepair>
```

5 Event Extensions

All IPC-2547 events can be extended. An element called Extensions may be included in each event. See the IPC-2547 XML Schema section for a complete listing of the XML schema used in the IPC-2547 standard.

6 Event Sequences

Due to the nature of test and inspection, judgements regarding the status of processes and process steps are dependent on the analysis done by the algorithms being executed on the equipment. Recognizing this, liberties are given in the order in which events are reported vs. when they actually happened. The following are examples of measurement and analysis reporting sequences utilizing IPC-2541 and IPC-2547. Others are also valid.

6.1 Test Sequences

ItemIdentifierRead
ItemTransferIn
ItemTransferZone
ItemWorkStart
Measurement
Measurement
ProcessStepStatus

Measurement
ProcessStepStatus
…
ItemProcessStatus
ItemWorkComplete
ItemTransferZone
ItemTransferOut

ItemIdentifierRead
ItemTransferIn
ItemTransferZone
ItemWorkStart
ItemProcessStatus
ProcessStepStatus
Measurement
Measurement

ProcessStepStatus
Measurement
…
ItemWorkComplete
ItemTransferZone
ItemTransferOut

6.2 Inspection Sequences

ItemIdentifierRead
ItemTransferIn
ItemTransferZone
ItemWorkStart
RegionOfInterest
Measurement
Measurement
InspectionFrame
ProcessStepStatus
…
RegionOfInterest
Measurement
InspectionFrame
ProcessStepStatus
…
ItemProcessStatus
ItemWorkComplete
ItemTransferZone
ItemTransferOut

ItemIdentifierRead
ItemTransferIn
ItemTransferZone
ItemWorkStart
ItemProcessStatus
ProcessStepStatus
InspectionFrame
RegionOfInterest
Measurement
Measurement
…
ProcessStepStatus
InspectionFrame
RegionOfInterest
InspectionFrame
…
ItemWorkComplete
ItemTransferZone
ItemTransferOut

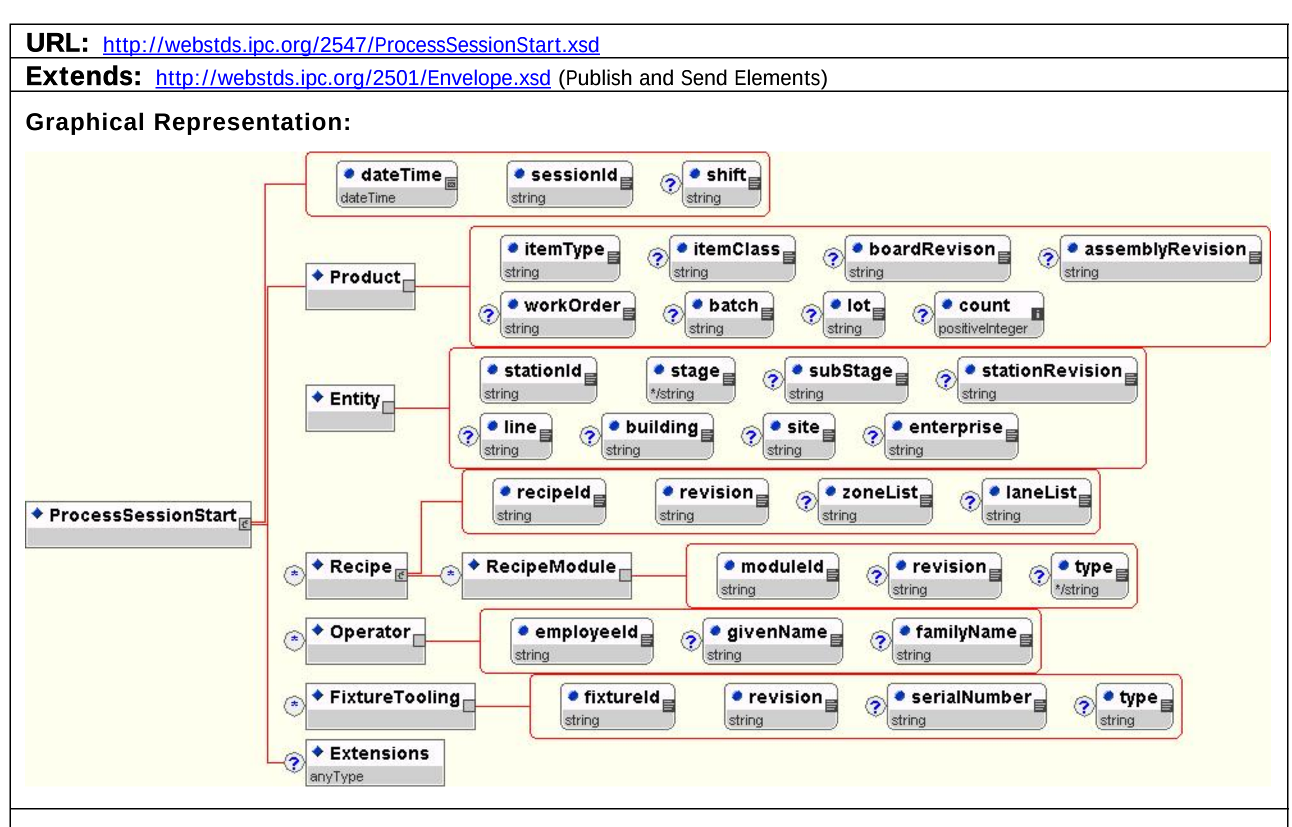
7 IPC-2547 XML Schema Definition

7.1 ProcessSessionStart

URL: http://webstds.ipc.org/2547/ProcessSessionStart.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

Graphical Representation:



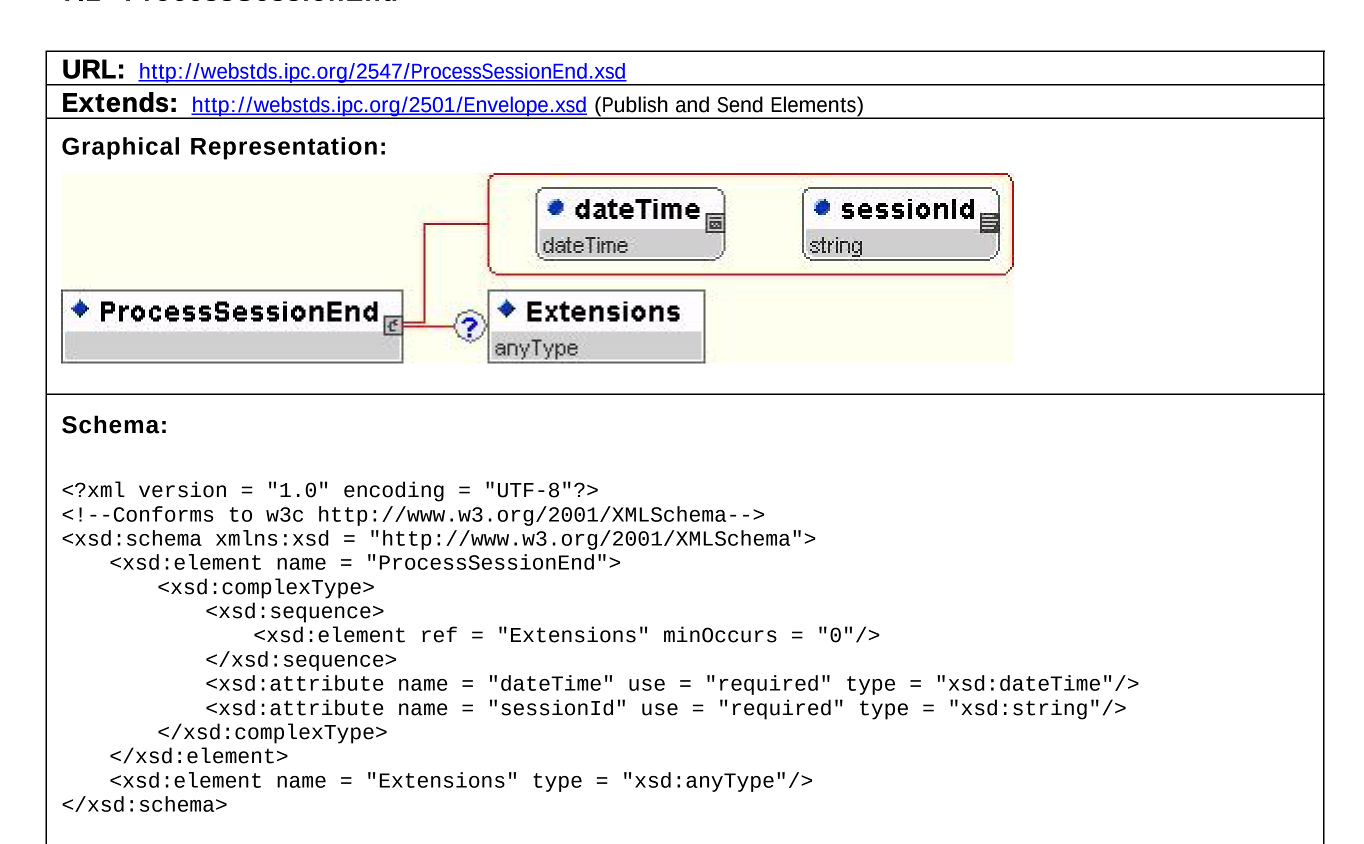
Schema:

```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ProcessSessionStart">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Product"/>
                <xsd:element ref = "Operator" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Entity"/>
                <xsd:element ref = "Recipe" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "FixtureTooling" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "sessionId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "shift" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Product">
        <xsd:complexType>
            <xsd:attribute name = "itemType" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemClass" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "boardRevison" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "assemblyRevision" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "workOrder" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "batch" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "lot" use = "optional" type = "xsd:string"/>
```

```
            <xsd:attribute name = "count" use = "optional" type = "xsd:positiveInteger"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Entity">
        <xsd:complexType>
            <xsd:attribute name = "stationId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "stage" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "MVI"/>
                        <xsd:enumeration value = "ALI"/>
                        <xsd:enumeration value = "AOI"/>
                        <xsd:enumeration value = "MXI"/>
                        <xsd:enumeration value = "AXI"/>
                        <xsd:enumeration value = "MDA"/>
                        <xsd:enumeration value = "FPT"/>
                        <xsd:enumeration value = "ICT"/>
                        <xsd:enumeration value = "FNT"/>
                        <xsd:enumeration value = "INT"/>
                        <xsd:enumeration value = "SYS"/>
                        <xsd:enumeration value = "OLT"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "subStage" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "stationRevision" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "line" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "building" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "site" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "enterprise" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Recipe">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "RecipeModule" minOccurs = "0" maxOccurs = "unbounded"/>
            </xsd:sequence>
            <xsd:attribute name = "recipeId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "revision" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "zoneList" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "laneList" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "RecipeModule">
        <xsd:complexType>
            <xsd:attribute name = "moduleId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "revision" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "type" use = "optional">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "ALGORITHM"/>
                        <xsd:enumeration value = "CONFIGURATION"/>
                        <xsd:enumeration value = "DOCUMENTATION"/>
                        <xsd:enumeration value = "EXECUTIVE"/>
                        <xsd:enumeration value = "FIRMWARE"/>
                        <xsd:enumeration value = "LIMITS"/>
                        <xsd:enumeration value = "SEQUENCE"/>
                        <xsd:enumeration value = "SETUP"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Operator">
        <xsd:complexType>
            <xsd:attribute name = "employeeId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "givenName" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "familyName" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "FixtureTooling">
```

```
        <xsd:complexType>
            <xsd:attribute name = "fixtureId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "revision" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "serialNumber" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "type" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

7.2 ProcessSessionEnd



URL: http://webstds.ipc.org/2547/ProcessSessionEnd.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

Graphical Representation:

Schema:

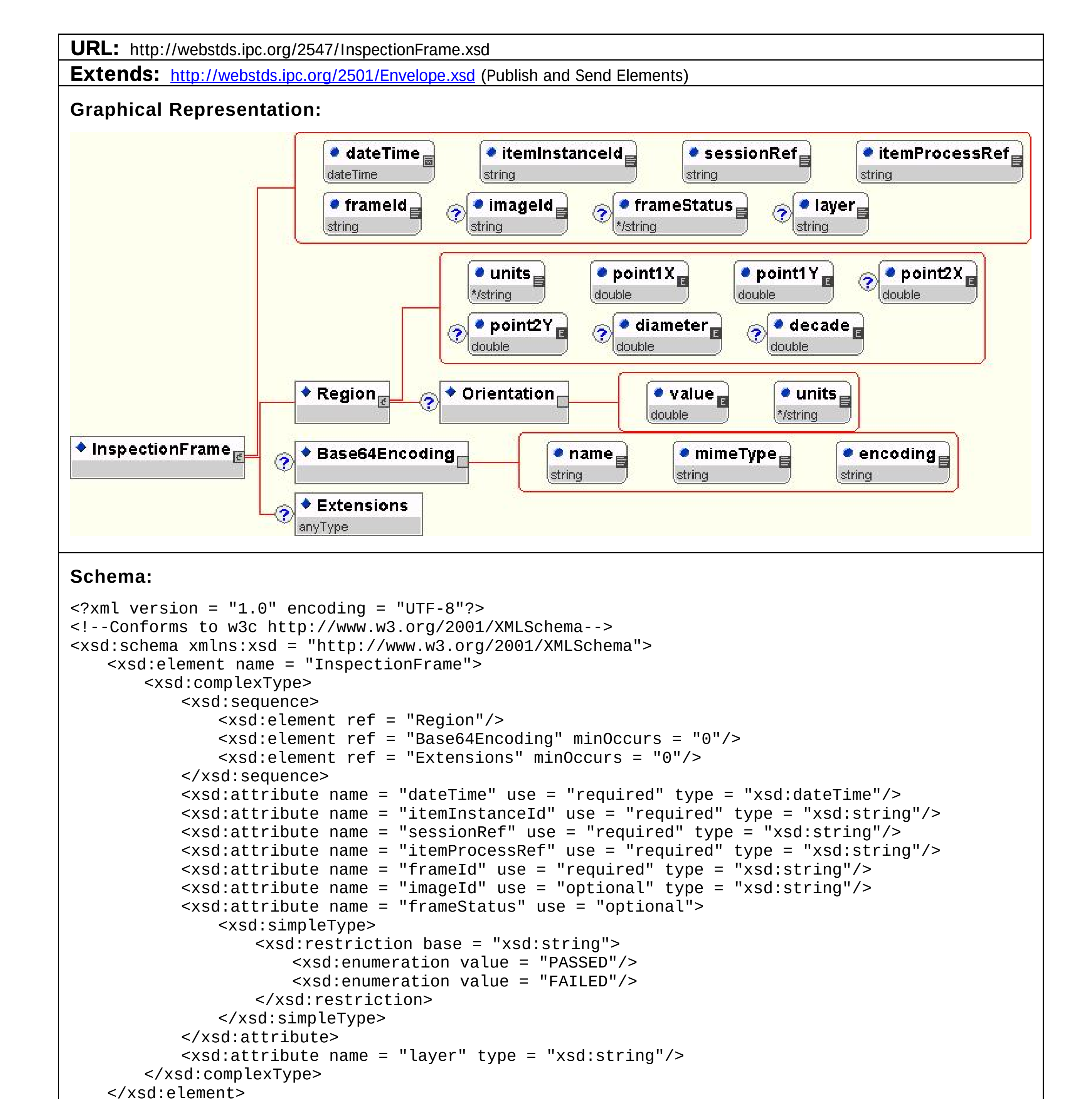
```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ProcessSessionEnd">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "sessionId" use = "required" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

7.3 InspectionFrame

URL: http://webstds.ipc.org/2547/InspectionFrame.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

Graphical Representation:



Schema:

```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "InspectionFrame">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Region"/>
                <xsd:element ref = "Base64Encoding" minOccurs = "0"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "itemInstanceId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "sessionRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemProcessRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "frameId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "frameStatus" use = "optional">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "PASSED"/>
                        <xsd:enumeration value = "FAILED"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "layer" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Region">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Orientation" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "INCH"/>
                        <xsd:enumeration value = "MM"/>
```

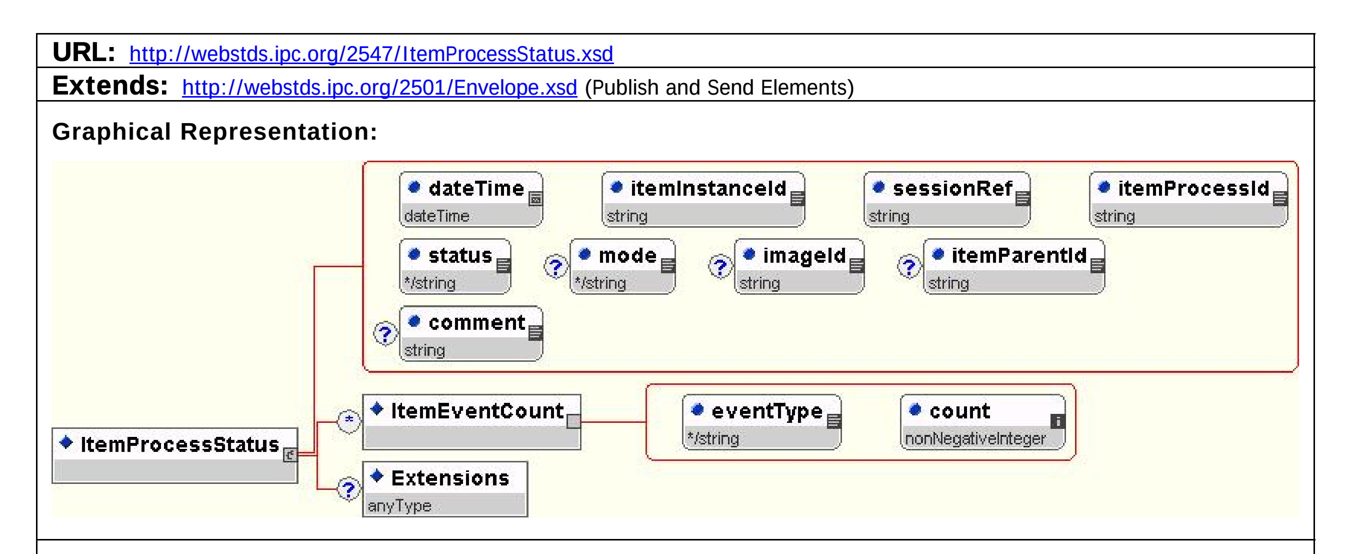
```
                        <xsd:enumeration value = "PIXEL"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "point1X" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "point1Y" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "point2X" use = "optional" type = "xsd:double"/>
            <xsd:attribute name = "point2Y" use = "optional" type = "xsd:double"/>
            <xsd:attribute name = "diameter" use = "optional" type = "xsd:double"/>
            <xsd:attribute name = "decade" default = "0" type = "xsd:double"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Orientation">
        <xsd:complexType>
            <xsd:attribute name = "value" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "DEGREES"/>
                        <xsd:enumeration value = "RADIANS"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Base64Encoding">
        <xsd:complexType>
            <xsd:attribute name = "name" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "mimeType" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "encoding" use = "required" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

7.4 ItemProcessStatus

URL: http://webstds.ipc.org/2547/ItemProcessStatus.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

Graphical Representation:



Schema:

```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ItemProcessStatus">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "ItemEventCount" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "itemInstanceId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "sessionRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemProcessId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "status" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "NOTEST"/>
                        <xsd:enumeration value = "PASSED"/>
                        <xsd:enumeration value = "FAILED"/>
                        <xsd:enumeration value = "ABORTED"/>
                        <xsd:enumeration value = "ERROR"/>
                        <xsd:enumeration value = "KNOWNGOOD"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
             <xsd:attribute name = "mode" use = "optional">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "CALIBRATION"/>
                        <xsd:enumeration value = "ENGINEERING"/>
                        <xsd:enumeration value = "PRODUCTION"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "itemParentId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "comment" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "ItemEventCount">
        <xsd:complexType>
            <xsd:attribute name = "eventType" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
```

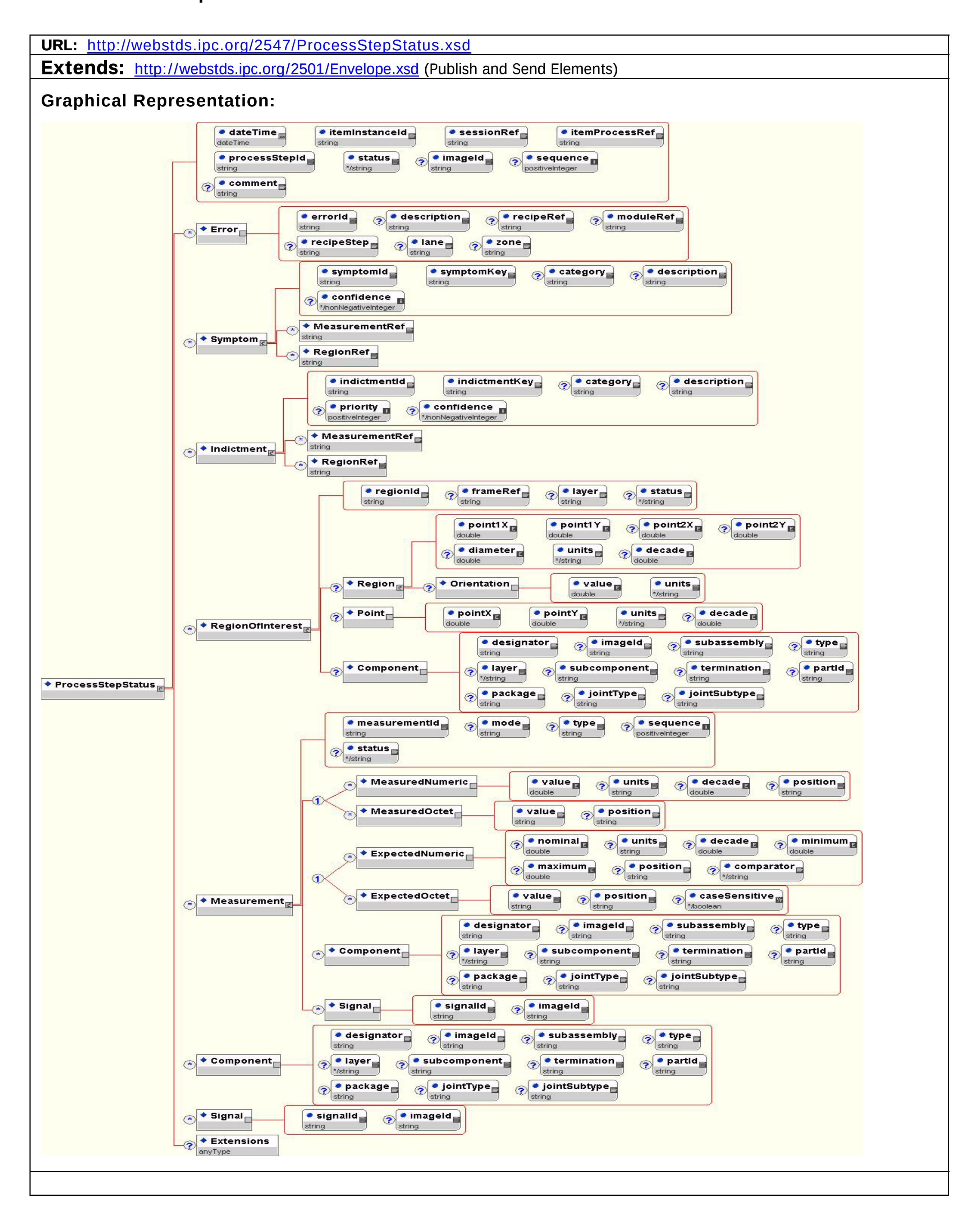
```
                        <xsd:enumeration value = "PROCESSSTEPSTATUS"/>
                        <xsd:enumeration value = "INSPECTIONFRAME"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "count" use = "required" type = "xsd:nonNegativeInteger"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

7.5 ProcessStepStatus

URL: http://webstds.ipc.org/2547/ProcessStepStatus.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

Graphical Representation:



Schema:

```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ProcessStepStatus">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Error" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Symptom" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Indictment" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "RegionOfInterest" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Measurement" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Component" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Signal" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "itemInstanceId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "sessionRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemProcessRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "processStepId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "status" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "ERROR"/>
                        <xsd:enumeration value = "FAILED"/>
                        <xsd:enumeration value = "NOTEST"/>
                        <xsd:enumeration value = "PASSED"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "sequence" use = "optional" type = "xsd:positiveInteger"/>
            <xsd:attribute name = "comment" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Error">
        <xsd:complexType>
            <xsd:attribute name = "errorId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "description" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "recipeRef" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "moduleRef" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "recipeStep" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "lane" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "zone" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Symptom">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "MeasurementRef" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "RegionRef" minOccurs = "0" maxOccurs = "unbounded"/>
            </xsd:sequence>
            <xsd:attribute name = "symptomId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "symptomKey" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "description" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "confidence" use = "optional">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:nonNegativeInteger">
                        <xsd:maxInclusive value = "100"/>
                        <xsd:minInclusive value = "0"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Indictment">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "MeasurementRef" minOccurs = "0" maxOccurs = "unbounded"/>
```

```
            <xsd:element ref = "RegionRef" minOccurs = "0" maxOccurs = "unbounded"/>
        </xsd:sequence>
        <xsd:attribute name = "indictmentId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "indictmentKey" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "category" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "description" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "priority" use = "optional" type = "xsd:positiveInteger"/>
        <xsd:attribute name = "confidence" use = "optional">
            <xsd:simpleType>
                <xsd:restriction base = "xsd:nonNegativeInteger">
                    <xsd:maxInclusive value = "100"/>
                    <xsd:minInclusive value = "0"/>
                </xsd:restriction>
            </xsd:simpleType>
        </xsd:attribute>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "RegionOfInterest">
    <xsd:complexType>
        <xsd:sequence>
            <xsd:element ref = "Region" minOccurs = "0"/>
            <xsd:element ref = "Point" minOccurs = "0"/>
            <xsd:element ref = "Component" minOccurs = "0"/>
        </xsd:sequence>
        <xsd:attribute name = "regionId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "frameRef" type = "xsd:string"/>
        <xsd:attribute name = "layer" type = "xsd:string"/>
        <xsd:attribute name = "status">
            <xsd:simpleType>
                <xsd:restriction base = "xsd:string">
                    <xsd:enumeration value = "PASSED"/>
                    <xsd:enumeration value = "FAILED"/>
                </xsd:restriction>
            </xsd:simpleType>
        </xsd:attribute>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "Measurement">
    <xsd:complexType>
        <xsd:sequence>
            <xsd:choice>
                <xsd:element ref = "MeasuredNumeric" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "MeasuredOctet" minOccurs = "0" maxOccurs = "unbounded"/>
            </xsd:choice>
            <xsd:choice>
                <xsd:element ref = "ExpectedNumeric" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "ExpectedOctet" minOccurs = "0" maxOccurs = "unbounded"/>
            </xsd:choice>
            <xsd:element ref = "Component" minOccurs = "0" maxOccurs = "unbounded"/>
            <xsd:element ref = "Signal" minOccurs = "0" maxOccurs = "unbounded"/>
        </xsd:sequence>
        <xsd:attribute name = "measurementId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "mode" type = "xsd:string"/>
        <xsd:attribute name = "type" type = "xsd:string"/>
        <xsd:attribute name = "sequence" type = "xsd:positiveInteger"/>
        <xsd:attribute name = "status">
            <xsd:simpleType>
                <xsd:restriction base = "xsd:string">
                    <xsd:enumeration value = "PASSED"/>
                    <xsd:enumeration value = "FAILED"/>
                </xsd:restriction>
            </xsd:simpleType>
        </xsd:attribute>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "MeasuredNumeric">
    <xsd:complexType>
        <xsd:attribute name = "value" use = "required" type = "xsd:double"/>
        <xsd:attribute name = "units" type = "xsd:string"/>
        <xsd:attribute name = "decade" use = "optional" type = "xsd:double"/>
        <xsd:attribute name = "position" type = "xsd:string"/>
```

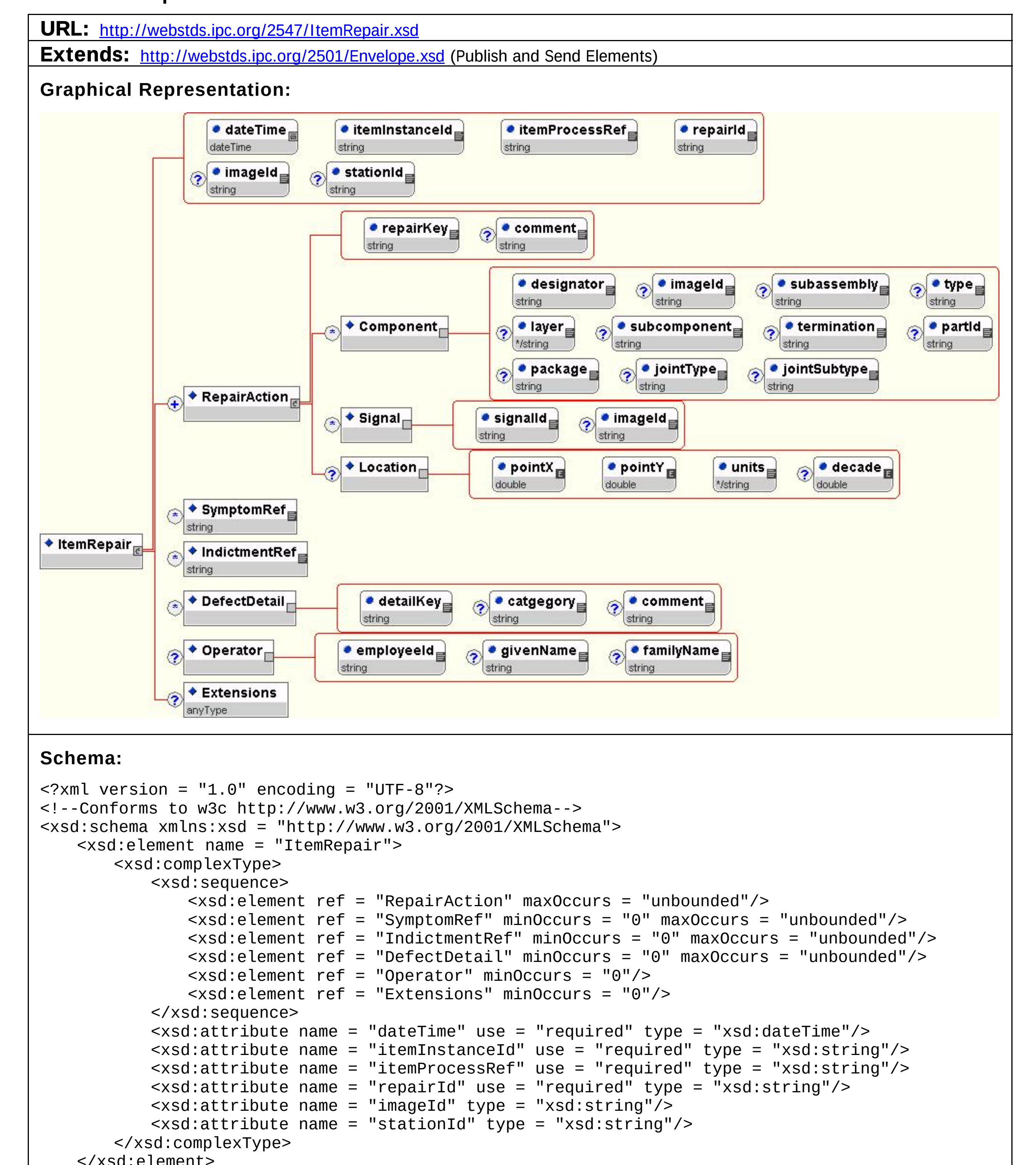
```
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "MeasuredOctet">
        <xsd:complexType>
            <xsd:attribute name = "value" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "position" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "ExpectedNumeric">
        <xsd:complexType>
            <xsd:attribute name = "nominal" type = "xsd:double"/>
            <xsd:attribute name = "units" type = "xsd:string"/>
            <xsd:attribute name = "decade" type = "xsd:double"/>
            <xsd:attribute name = "minimum" type = "xsd:double"/>
            <xsd:attribute name = "maximum" type = "xsd:double"/>
            <xsd:attribute name = "position" type = "xsd:string"/>
            <xsd:attribute name = "comparator">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "EQ"/>
                        <xsd:enumeration value = "NE"/>
                        <xsd:enumeration value = "GT"/>
                        <xsd:enumeration value = "LT"/>
                        <xsd:enumeration value = "GE"/>
                        <xsd:enumeration value = "LE"/>
                        <xsd:enumeration value = "GTLT"/>
                        <xsd:enumeration value = "GELE"/>
                        <xsd:enumeration value = "GTLE"/>
                        <xsd:enumeration value = "GELT"/>
                        <xsd:enumeration value = "LTGT"/>
                        <xsd:enumeration value = "LEGE"/>
                        <xsd:enumeration value = "LTGE"/>
                        <xsd:enumeration value = "LEGT"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "ExpectedOctet">
        <xsd:complexType>
            <xsd:attribute name = "value" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "position" type = "xsd:string"/>
            <xsd:attribute name = "caseSensitive">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:boolean">
                        <xsd:enumeration value = "TRUE"/>
                        <xsd:enumeration value = "FALSE"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Region">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Orientation" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "point1X" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "point1Y" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "point2X" type = "xsd:double"/>
            <xsd:attribute name = "point2Y" type = "xsd:double"/>
            <xsd:attribute name = "diameter" type = "xsd:double"/>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "MM"/>
                        <xsd:enumeration value = "INCH"/>
                        <xsd:enumeration value = "PIXEL"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
```

```
            <xsd:attribute name = "decade" default = "0" type = "xsd:double"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Orientation">
        <xsd:complexType>
            <xsd:attribute name = "value" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "DEGREES"/>
                        <xsd:enumeration value = "RADIANS"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Point">
        <xsd:complexType>
            <xsd:attribute name = "pointX" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "pointY" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "MM"/>
                        <xsd:enumeration value = "INCH"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "decade" default = "0" type = "xsd:double"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Component">
        <xsd:complexType>
            <xsd:attribute name = "designator" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "subassembly" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "type" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "layer" use = "optional">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "TOP"/>
                        <xsd:enumeration value = "BOTTOM"/>
                        <xsd:enumeration value = "INTERNAL"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "subcomponent" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "termination" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "partId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "package" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "jointType" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "jointSubtype" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Signal">
        <xsd:complexType>
            <xsd:attribute name = "signalId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "RegionRef" type = "xsd:string"/>
    <xsd:element name = "MeasurementRef" type = "xsd:string"/>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

7.6 ItemRepair

URL: http://webstds.ipc.org/2547/ItemRepair.xsd
Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

Graphical Representation:



Schema:

```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ItemRepair">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "RepairAction" maxOccurs = "unbounded"/>
                <xsd:element ref = "SymptomRef" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "IndictmentRef" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "DefectDetail" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Operator" minOccurs = "0"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "itemInstanceId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemProcessRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "repairId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" type = "xsd:string"/>
            <xsd:attribute name = "stationId" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "RepairAction">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Component" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Signal" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Location" minOccurs = "0"/>
```

```
            </xsd:sequence>
            <xsd:attribute name = "repairKey" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "comment" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Component">
        <xsd:complexType>
            <xsd:attribute name = "designator" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" type = "xsd:string"/>
            <xsd:attribute name = "subassembly" type = "xsd:string"/>
            <xsd:attribute name = "type" type = "xsd:string"/>
            <xsd:attribute name = "layer">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "TOP"/>
                        <xsd:enumeration value = "BOTTOM"/>
                        <xsd:enumeration value = "INTERNAL"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "subcomponent" type = "xsd:string"/>
            <xsd:attribute name = "termination" type = "xsd:string"/>
            <xsd:attribute name = "partId" type = "xsd:string"/>
            <xsd:attribute name = "package" type = "xsd:string"/>
            <xsd:attribute name = "jointType" type = "xsd:string"/>
            <xsd:attribute name = "jointSubtype" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Signal">
        <xsd:complexType>
            <xsd:attribute name = "signalId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Location">
        <xsd:complexType>
            <xsd:attribute name = "pointX" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "pointY" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "MM"/>
                        <xsd:enumeration value = "INCH"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "decade" default = "0" type = "xsd:double"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "IndictmentRef" type = "xsd:string"/>
    <xsd:element name = "SymptomRef" type = "xsd:string"/>
    <xsd:element name = "DefectDetail">
        <xsd:complexType>
            <xsd:attribute name = "detailKey" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "catgegory" type = "xsd:string"/>
            <xsd:attribute name = "comment" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Operator">
        <xsd:complexType>
            <xsd:attribute name = "employeeId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "givenName" type = "xsd:string"/>
            <xsd:attribute name = "familyName" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "MeasurementRef" type = "xsd:string"/>
    <xsd:element name = "RegionRef" type = "xsd:string"/>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

Appendix A – Acronym Definitions

AOI	Automated Optical Inspection
ALI	Automated Laser Inspection
AXI	Automated X-ray Inspection
EQ	Comparator *Equal To*
FNT	Functional Test
FOV	Field Of View
FPT	Flying Probe Test
GE	Comparator *Greater Than or Equal To*
GELE	Comparator *Greater Than or Equal To or Less Than or Equal To*
GELT	Comparator *Greater Than or Equal To or Less Than*
GT	Comparator *Greater Than*
GTLE	Comparator *Greater Than or Less Than or Equal To*
GTLT	Comparator *Greater Than or Less Than*
ICT	In-Circuit Test
INT	System Integration Test
LE	Comparator *Less Than or Equal To*
LEGE	Comparator *Less Than or Equal To* or *Greater Than or Equal To*
LEGT	Comparator *Less Than or Equal To* or *Greater Than*
LT	Comparator *Less Than*
LTGE	Comparator *Less Than* or *Greater Than or Equal To*
LTGT	Comparator *Less Than* or *Greater Than*
MDA	Manufacturing Defect Analyzer
MVI	Manual Visual Inspection
MXI	Manual X-ray Inspection
NE	Comparator *Not Equal To*
OLT	Off-Line Test (Sampling)
ROI	Region Of Interest
SYS	Full System Test

Appendix B – Example Symptoms

The following is a listing of recommended non-conformances for possible use in the Symptom record.

CLOCK REFERENCE FAILURE
CLOCK SYNCHRONIZATION FAILURE
RECEPTION FAILURE
SIGNAL DEGRADATION FAILURE
SIGNAL INTERMITTENT FAILURE
SYSTEM CLOCK FAILURE
SYSTEM OVERCURRENT FAILURE
SYSTEM OVERVOLTAGE FAILURE
SYSTEM TIMEOUT FAILURE
SYSTEM UNDERCURRENT FAILURE
SYSTEM UNDERVOLTAGE FAILURE
TRANSMISSION FAILURE
VOLTAGE OFFSET FAILURE
VOLTAGE REFERENCE FAILURE

Appendix C – Example Indictments

The following is a listing of recommended non-conformances for use in the Indictment record.

ADHESIVE APPLICATION WRONG
ADHESIVE CONSISTENCY WRONG
ADHESIVE CONTAMINATED
ADHESIVE EXCESSIVE VOLUME
ADHESIVE INSUFFICIENT VOLUME
ADHESIVE MISSING
ADHESIVE NOT CURED
AIR GAP VIOLATION
BOARD CONTAMINATED
BOARD DAMAGED
BOARD DIRTY
BOARD WARPED
CABLE BAD SPLICE
CABLE DAMAGED
CABLE LENGTH WRONG
CABLE MISCONNECTED
CABLE MISCONSTRUCTED
CABLE ROUTING WRONG
CABLE STRESSED
CABLE WIRE BIRDCAGED
COATING BLISTERED
COATING CONTAMINATED
COATING INSUFFICIENT
COATING MISSING
COATING PEELING
COMPONENT BILLBOARDED
COMPONENT COPLANARITY BAD
COMPONENT DAMAGED
COMPONENT INCOMPATIBLE
COMPONENT LEAD BENT
COMPONENT LEAD MISFORMED
COMPONENT LEAD MISSING
COMPONENT LEAD NOT THROUGH
COMPONENT LEAD STRESSED
COMPONENT LOOSE
COMPONENT MISALIGNED
COMPONENT MISSING
COMPONENT OBSOLETE
COMPONENT OFFSET
COMPONENT POLARITY WRONG
COMPONENT PREPARATION WRONG
COMPONENT PROGRAM WRONG
COMPONENT ROTATION SKEWED
COMPONENT TOMBSTONED
COMPONENT UNPREPARED
COMPONENT VALUE OF OF TOLERANCE
COMPONENT WRONG HEIGHT
COMPONENT WRONG PART
COMPONENT WRONG SUPPLIER
FIXTURE CONTACT PROBLEM
HARDWARE DEFECTIVE
HARDWARE LOOSE
HARDWARE MISMOUNTED
HARDWARE MISSING
HARDWARE WRONG
HIGH POTENTIAL FAILURE
INSULATION CLEARANCE WRONG
INSULATION DAMAGED
INSULATION MISSING
MARKING ILLEGABLE
MARKING INCOMPLETE
MARKING WRONG
MARKING WRONG COLOR
MARKING WRONG TEXT
MASK INCOMPLETE
MASK OVERFLOW
MASK WET
MASK WRONG
MOUNTING BROKEN
MOUNTING INCOMPLETE
MOUNTING WRONG
OPEN
SHORT
SOLDE PASTE SMEARED
SOLDER BALL
SOLDER BRIDGE
SOLDER COLD JOINT
SOLDER DISTURBED
SOLDER EXCESSIVE VOLUME
SOLDER FRACTURED
SOLDER ICICLES
SOLDER INSUFFICIENT HEEL
SOLDER INSUFFICIENT TOE
SOLDER INSUFFICIENT VOLUME
SOLDER MISSING
SOLDER PASTE CONTAMINATED
SOLDER PASTE EXCESSIVE HEIGHT
SOLDER PASTE EXCESSIVE VOLUME
SOLDER PASTE INSUFFICIENT HEIGHT
SOLDER PASTE INSUFFICIENT VOLUME
SOLDER PASTE MISSHAPED
SOLDER PASTE MISSING
SOLDER PASTE SMEAR
SOLDER PASTE STALE
SOLDER PASTE VOID
SOLDER PASTE WRONG CONSISTENCY
SOLDER PASTE WRONG FLUX
SOLDER POOR WETTING
SOLDER SMEAR
SOLDER VOID

TRACE CAPACITANCE WRONG
TRACE ETCHING OPEN
TRACE ETCHING SHORT
TRACE IMPEDENCE WRONG
WIRE DAMAGED
WIRE MISCRIMPED
WIRE MISROUTED
WIRE MISSING
WIRE NOT CONNECTED
WIRE NOT TINNED
WIRE SLEEVING WRONG

Appendix D – Example Repair Actions

The following is a listing of recommended repair actions for use in the ItemRepair event record:

ADHESIVE REAPPLIED
BOARD RESERIALIZED
BOARD REWASHED
BOARD SCRAPPED
CABLE RECONNECTED
CABLE REPLACED
CABLE REROUTED
COMPONENT ADDED
COMPONENT REALIGNED
COMPONENT REMOUNTED
COMPONENT REMOVED
COMPONENT REPAIRED
COMPONENT REPLACED
COMPONENT REPROGRAMMED
HARDWARE REMOUNTED
HARDWARE REPLACED
NO DEFECT FOUND
NOT REPAIRED
SOLDER ADDED
SOLDER REMOVED
SOLDER RETOUCHED
WIRE RECONNECTED
WIRE REPLACED
WIRE REROUTED
WIRE RETINNED

Appendix E – Example Indictment/Symptom Categories

ASSEMBLY
BUILDUP
COMPONENT
CONNECTION
CONTAMINATION
DESIGN
DISPENSING
DOCUMENTATION
ENVIRONMENTAL
ETCH
FABRICATION
GLUE
HANDLING
LABELING
MACHINE
MANUAL
MATERIALS
MECHANICAL
PASTE
PRINTING
REGISTRATION
THERMAL
TOOLING

Appendix F – Suggested Component Types
(Reference IPC-2511A)

ANALOG
ANTENNA
BACKPLANE
BRIDGE
CABLE
CABLEEND
CAGE
CAP
CARD
CONN
CPCK
DAUGHTERBOARD
DIAC
DIODE
FUSE
HARNESS
HYBRID
IND
JUMPER
LED
LEDPCK
LOGIC
MOTHERBOARD
NFET
NPN
OPAMP
OPTO
OSCIL
PCAP
PFET
PNP
POWERSUPPLY
RELAY
RES
RPCK
SCR
SOCKET
SWITCH
VCAP
VIND
VREG
VRES
XFMR
ZENER

Appendix G – Suggested Component Package Types
(Reference IPC-2511A)

AXIAL_LEADED
BARE_DIE
CERAMIC_BGA
CERAMIC_DIP
CERAMIC_FLATPACEK
CERAMIC_QUAD_FLATPACK
CERAMIC_SIP
CHIP
CHIP_SCALE
COIL_CHOKE
CONNECTOR_SM
CONNECTOR_TH
EMBEDDED
FLIPCHIP
HERMETIC_HYBRID
INI_BGA
LEADLESS_CERAMIC_CHIP_CARRIER
MCM
MELF
MOLDED
NETWORK
PGA
PLASTIC_BCA
PLASTIC_CHIP_CARRIER
PLASTIC_DIP
PLASTIC_SIP
POWER_TRANSISTOR
RADIAL_LEADED
RECTANGULAR_QUAD_FLATPACK
RELAY_SM
RELAY_TH
SOC
SOD123
SOIC
SOJ
SOPIC
SOT143
SOT23
SOT52
SOT89
SQUARE_QUAD_FLATPACK
SSOIC
SWITCH
TO_TYPE
TRANSFORMER
TRIMPOT_SM
TRIMPOT_TH
TSOP

Appendix H – Example Package Lead Types
(Reference IPC-2511A)

BALL
BUMP
BUTTLEAD
CASTELLATION
COLUMN
GULLWING
JLEAD
LAND
SLEAD
TERMINATION
TH_RIBBON
TH_ROUND
TH_V
WRAPAROUND

Appendix I - IPC Web-based Standards (IPC25XX)

The web-based standards (IPC 25XX) are designed to foster application integration and electronic commerce through data and information interchange standards based on XML. It assumes that application programs (including equipment interfaces) are distinct entities, and application integration takes place using a loosely coupled, message-passing approach. There is no need for a common object model, programming language, network protocol, persistent storage mechanism or operating system for two applications to exchange XML messages formatted using the web-based standards. The two applications simply need to be able to format, transmit, receive and consume a standardized XML message.

The web-based standards series have been identified for each of the value-added activities occurring throughout the product life cycle of an electronics product. The web-based standards are:

IPC-2500 – Framework Standard

IPC-2510 – Product Data Representation

IPC-2520 – Product Data Quality

IPC-2530 – Surface Mount Equipment Standard Recipe File Format

IPC-2540 – Shop Floor Equipment Communications

IPC-2550 – Manufacturing Execution Systems Communications

IPC-2560 – Enterprise Resource Planning Systems Communications

IPC-2570 – Supply Chain Communications

Table I-1 shows the correlation of the different standards in each of the series. Although not every standard has been started, the figure represents a coordinated opportunity to maintain consistency throughout the standard development cycle.

Table I-1 CAD/CAM Standardization

IPC Number/ Function	-xxx1 Generic	-xxx2 Administ	-xxx3 Documnt	-xxx4 Board Fabricat	-xxx5 Bare Bd Test	-xxx6 Assy Manufac	-xxx7 Assy/ Test/ Insp.	-xxx8 Comp. & Material	-xxx9 Informa. Modeling
IPC-2500 CAMX Framework	IPC-2501 PINS								
IPC-2510 GenCAM Product Data	IPC-2511A (Pub)	IPC-2512A (Pub)	IPC-2513A (Pub)	IPC-2514A (Pub)	IPC-2515A (Pub)	IPC-2516A (Pub)	IPC-2517A (Pub)	IPC-2518A (Pub)	IPC-2519A (Pub)
IPC-2520 Quality Product Data				IPC-2524 (Pub)					
IPC-2530 SRFF Process Data Recipe file	IPC-2531 (Pub)								
IPC-2540 Shop Floor Communicate	IPC-2541 (Pub)					IPC-2546 (Pub)	IPC-2547 (Pub)		
IPC-2550 Execution Communicate	IPC-2551 PINS			IPC-2554 Working draft		IPC-2556 PINS			
IPC-2560 Enterprise Communicate									
IPC-2570 Supply Chain Communicate	IPC-2571 (Pub)					IPC-2576 (Pub)	IPC-2577 Proposal	IPC-2678 (Pub)	

Messages are the basis of the web-based standards. Messages are the means to integrate applications at the business-process level by defining a loosely coupled, request-based communication process. Since many business processes involve one party performing a service at the request of another party, the mapping of messages to requests is natural. An XML-based messaging system with open, extensible formats captures the essential elements of an electronics business communication message while allowing flexible implementations.